PROBABILISTIC ASSESSMENT OF A STATIC FRAME MODEL

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Mathematical models are being increasingly used in design decision making process for various engineering systems. The reliability or performance of real structures is being assessed using closed form equations. Often these models are built using existing empirical data or physics based assumptions. The models might have errors and hence may not capture the real system behavior effectively. Also, the predictions have variations due to the propagation of input uncertainties via the mathematical model. The risks involved in accepting the model predictions can be minimized by rigorously verifying and validating the math model. The experimental data to be used for validation is often obtained with limited precision and the sample size may not be adequate. Sometimes, the measurements may not even cover the region of intended model use or the application domain. In order to quantitatively assess the model quality, statistical model validation involves comparison of two or more sets of uncertain quantities. Validation metrics may be defined to measure the closeness of model predictions to the data. The form of metric and validation inference depend on the nature of model output and availability of data.

The authors will address the static frame problem assigned to them by the workshop organizers. The prediction model involves displacement of beam with heterogeneous elastic modulus and is a part of a static frame. A non-Gaussian stationary field will be used to characterize the underlying variation of elastic modulus along the length of the beam. Maximum likelihood methods will be employed for the calibration of parameters that describe the random field. The calibrated material property model is then used in predicting the statistical distribution

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of displacement of the beam under different conditions. Further the calibrated model is validated using the given test data of different sample sizes. Anderson-Darling statistical hypothesis tests will be explored for inferring whether the sample set belongs to the distribution of model output. Further, the inherent model bias distribution will be derived. In addition to a validation exercise, the model is further used for predicting in an application region where the test data is very sparse. Ultimately, the probability of a real structure meeting the regulatory requirements is quantified and a relation between reliability prediction and model bias will be established.